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EXPERIMENTAL APPARATUS FOR MICROWAVE IRRADIATION OF PROTEIN SOLUTIONS

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In the light of studies of the mechanics of the biological effect of microwaves it is interesting to find out whether it is possible to change the physico-chemical characteristics of protein solutions with microwaves. However, this is associated with methodological difficulties resulting from the necessity of measuring the parameters of the solutions studied during irradiation.

The present paper describes an experimental apparatus which makes it possible to measure certain physico-chemical parameters of solutions during their irradiation with definite amounts of microwaves in the 10 cm range.

Fig. 1 shows the basic circuit of the apparatus. The microwave energy from generator 1 is delivered to the waveguide transition 2 through a cable. The microwaves (H_{10} mode) excited in the transition are transmitted through the waveguide channel which consists of an attenuator 3, a measuring line 4, a power-level indicator 5, 6, an impedance transformer 7, and, finally, a waveguide cell with a piston 9 which houses the test tube with the solution under study 8.

If the piston is set at a distance of one quarter of a wavelength (in the waveguide) from the test tube, the latter will be located at the antinode of standing waves. As we know, the compensation of reflections in the transformer-piston area may be achieved by properly tuning the impedance transformer in such a way that practically all the microwave energy flowing toward this area from the generator is absorbed in the only active element – the solution. Such compensation is controlled by measuring the coefficient of the traveling wave (CTW) by means of the measuring line.

The microwave energy, directed along the waveguide channel to the test tube with the solution, is measured by the attenuator and is controlled by the power-level indicator, graduated in power units. Graduation is achieved by means of a directional coupler (connected between the measuring line and the power-level indicator), to which a microwave power meter is connected.

To measure the electrical parameters of the solution during irradiation (electrical conductivity, pH, dielectric permeability) a test tube with flat platinum electrodes can be used. The distance between the electrodes must be large enough so that when the test tube is placed in the waveguide the electrodes are outside of the latter.

The viscosity of the solution can be measured during irradiation by means of an Oswald viscosimeter, placed in the waveguide cell instead of the test tube.

The apparatus being described uses standard waveguide components. The cross section of the waveguide is 72 x 32 mm. The power-level indicator is a section of the waveguide with a detector head. The detector is connected to an M-24 microammeter.

The waveguide cell for the irradiation of the solution is shown in Fig. 2. The piston is moved

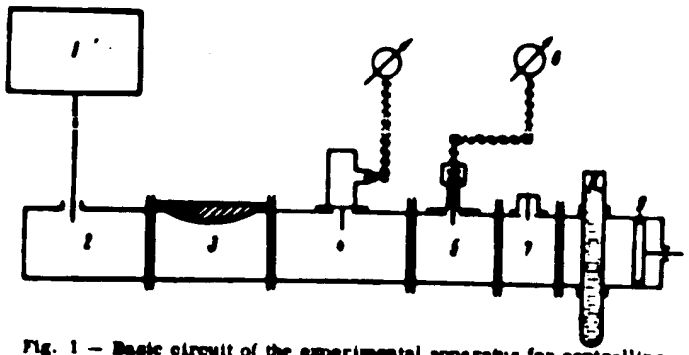

Fig. 1 – Basic circuit of the experimental apparatus for controlling the amount of microwave energy in the 10 cm range applied to protein solutions.

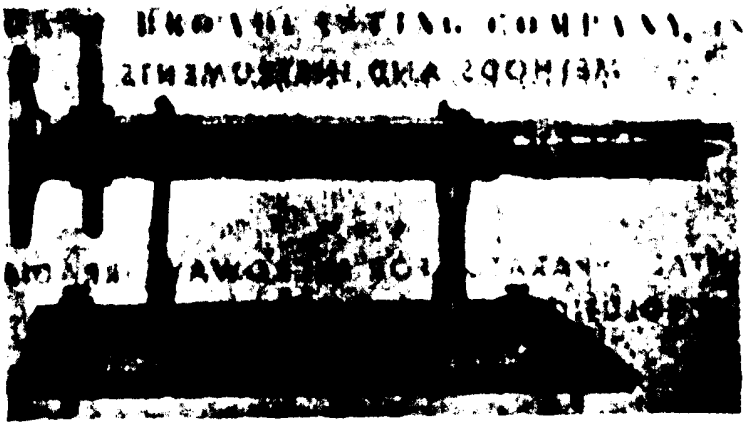

Fig. 2 – General view of the waveguide cell housing the test tube (or viscosimeter) with the solution under study.

in the cell by means of a micrometric head. There are special grooves in the openings for the leads of electrodes to the test tube when the latter is placed in the waveguide cell.

The electrodes are rectangular, 6 x 6 mm in size, and placed 70 mm apart. The electrode leads, soldered into the wall of the test tube, extend 6-7 mm outside.

Tests showed that the apparatus satisfies its requirement – to permit measurement of electrical parameters and viscosity of protein solutions during irradiation with microwaves in the range from 8-12 cm, where the microwave power absorbed by the solution under study is controlled with sufficient accuracy. When a solution isotonic with animal blood plasma (Ringer's solution) is placed in the test tube, a CTW of 0.8 is obtained, i. e. an absorption by the solution of about 80% of the microwave power transmitted through the waveguide. Thus, the control accuracy is determined primarily by errors in the graduation of the power-level indicator. These errors do not exceed – 15% when a standard directional coupler and an EMM-6 power meter are used.

To standardize the investigations, control must be achieved in units of specific absorptive power of the solution, in mv/ml. The power-level indicator can be graduated in such units by dividing the measured power in the waveguide channel by the volume of the solution in the waveguide (the volume is 3.5 ml for a standard test tube and a waveguide cross section of 72 x 34 mm).

The apparatus is designed for the wavelength range from 9-12 cm. However, similar apparatus can be constructed for shorter waves (down to the 3 cm range) by using corresponding waveguide components and a horn of appropriate size.

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